



Summary of Evaluation with City Council-Adopted Criteria

Meadow / Charleston

Evaluation Criteria		Trench	Hybrid	Viaduct	South Palo Alto Tunnel Passenger and Freight	South Palo Alto Tunnel with At-Grade Freight	Underpass
A	Facilitate movement across the corridor for all modes of transportation	Meadow Dr and Charleston Rd will be grade separated from the railroad for all modes and will remain open.	Meadow Dr and Charleston Rd will be grade separated from the railroad for all modes and will remain open.	Meadow Dr and Charleston Rd will be grade separated from the railroad for all modes and will remain open. Viaduct provides opportunities for additional crossings for all modes.	Meadow Dr and Charleston Rd will be grade separated from the railroad for all modes and will remain open.	Meadow Dr and Charleston Rd will be grade separated from the passenger train traffic only for all modes and will remain open. Meadow Dr and Charleston Rd will not be grade separated from the freight train traffic.	East/West (through) traffic on Meadow Dr and Charleston Rd will be grade separated from the railroad and Alma St for all modes. Some turning movements on Meadow Dr to/from Alma St will be prohibited. All turning movements on Charleston Dr to/from Alma St will be permitted; however, some movements will be facilitated via a roundabout approximately 600 feet west of Alma St, resulting in longer routes for all modes.
B	Reduce delay and congestion for vehicular traffic at rail crossings	With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Dr and Charleston Rd will be removed. Thus, the traffic will not be interrupted by railroad crossing gates.	With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Dr and Charleston Rd will be removed. Thus, the traffic will not be interrupted by railroad crossing gates.	With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Dr and Charleston Rd will be removed. Thus, the traffic will not be interrupted by gates coming down.	With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Dr and Charleston Rd will be removed. Thus, the traffic will not be interrupted by gates coming down.	With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Dr and Charleston Rd will remain for the freight at-grade crossing. Freight train service is limited to just a few trains at night.	With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Dr and Charleston Rd will be removed. Thus, the traffic will not be interrupted by gates coming down. Pedestrian and cyclist mode separation will also help reduce intersection congestion.
C	Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles	Pedestrians/cyclists will be separated from train traffic and bike lanes will be added to Charleston Rd.	Pedestrians/cyclists will be separated from train traffic and bike lanes will be added to Charleston Rd.	Pedestrians/cyclists will be separated from train traffic and bike lanes will be added to Charleston Rd.	Pedestrians/cyclists will be separated from train traffic.	Pedestrians/cyclists will be separated from passenger train traffic only.	Pedestrians and cyclists traveling east/west will be completely separated from train and vehicular traffic on Alma St. Full pedestrian and cyclist movement is maintained. Pedestrians and cyclists will have more circuitous routes traveling east/west across the corridor because the ped/bike path is located on one side of the street only: On the south side of Meadow Dr and on the north side of Charleston Rd. For example, cyclists traveling eastbound on Charleston Rd near Ruthelma St will have to cross Charleston Rd to get onto the north side of the road, then cross Charleston Rd again at the roundabout near Mumford Pl to get back onto the right/south side of the road.
D	Support continued rail operations and Caltrain service improvements	A temporary railroad track will be required, and a crossover track located north of the San Antonio Caltrain Station will be relocated. With the pump stations, there will be potential risks to train operations from flooding.	A temporary railroad track will be required, and a crossover track located north of the San Antonio Caltrain Station will be relocated.	New railroad tracks can be built without a temporary track, and a crossover track located north of the San Antonio Caltrain Station will be relocated.	A temporary railroad track will be required at the boring pit areas to the north and south. A siding track will be relocated north of the California Ave Caltrain Station. Due to the pump stations, there will be potential risks to train operations due to flooding.	A temporary railroad track will be required at the boring pit areas to the north and south. A siding track will be relocated north of the California Ave Caltrain Station. Due to the pump stations, there will be potential risks to train operations due to flooding.	During construction, a temporary railroad track is likely to be required unless an alternate construction methodology and sequencing is acceptable to Caltrain.
E	Finance with feasible funding sources	The trench will require greater levels of local funding in the form of fees, taxes or special assessments, the feasibility of which are still being studied in the context of overall citywide infrastructure funding needs.	The hybrid would require lower levels of local funding, with a substantial portion of capital costs covered by Regional, State and Federal sources.	The viaduct would require substantial local funding resources more than the hybrid alternative, but less than the trench and tunnel alternatives.	The tunnel will require the greatest levels of local funding in the form of fees, taxes or special assessments, the feasibility of which are still being studied in the context of overall citywide infrastructure funding needs.	The tunnel will require the greatest levels of local funding in the form of fees, taxes or special assessments, the feasibility of which are still being studied in the context of overall citywide infrastructure funding needs. However, this alternative would not be eligible for grade separation funding as the at-grade crossing for freight would remain.	The underpass will require substantial local funding resources more than the hybrid alternative, but less than the trench and tunnel alternatives.
F	Minimize right-of-way acquisition	Subsurface acquisitions will be required for the ground anchors for the trench retaining walls and right-of-way acquisitions will be required to construct pump stations.	No acquisition of private properties is required; however, driveway modifications will be required.	No acquisition of private properties is required.	Subsurface acquisitions will be required for the ground anchors for the trench retaining walls and right of way acquisitions will be required to construct pump stations.	Subsurface acquisitions will be required for the ground anchors for the trench retaining walls and right of way acquisitions will be required to construct pump stations.	Multiple private property acquisitions are required, and driveway modifications are also likely to be required. There is also encroachment into Caltrain's right of way, permanently as well as during construction.
G	Reduce rail noise and vibration	Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing electric engines instead of diesel engines will also reduce noise. With the lowered track, train noise could reflect off walls and impact properties farther away, which can be mitigated.	Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing electric engines instead of diesel engines will also reduce noise. With the elevated track, train wheel noise could radiate out, which can be mitigated with a sound barrier.	Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing electric engines instead of diesel engines will also reduce noise. With the elevated track, train wheel noise could radiate out, which can be mitigated with a sound barrier.	Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing electric engines instead of diesel engines will also reduce noise. In the trench section, train noise could reflect off walls and impact properties farther away, which can be mitigated. In the tunnel section, train wheel noise will be contained.	Train horn noise and warning bells will remain for the at-grade crossings to accommodate the freight trains. Utilizing electric engines instead of diesel engines will also reduce noise. In the trench section, train noise could reflect off walls and impact properties farther away, which can be mitigated. In the tunnel section, train wheel noise will be contained.	Train horn noise and warning bells will be eliminated by the replacement of the at-grade crossings with grade separations. The use of electric motors rather than diesel engines will also reduce noise. Train wheel noise may increase at the bridge location, depending on structure type; however, this noise can be mitigated.
H	Maintain access to neighborhoods, parks, and schools along the corridor, while reducing regional traffic on neighborhood streets	No diversion of regional traffic with construction of grade separations.	No diversion of regional traffic with construction of grade separations.	No diversion of regional traffic with construction of grade separations.	No diversion of regional traffic with construction of grade separations.	Diversion of regional traffic with the permanent lane reduction on Alma St will impact residential streets. Turning movements at Ely Pl will be limited to right turns on northbound Alma St only.	Regional traffic will be diverted due to the restricted turning movements; however, travel in all directions will be possible, but may require a longer route and take more time. Pedestrian and cyclist access will significantly improve due to mode separation.
I	Minimize visual changes along the corridor	Railroad tracks will be below grade with high fencing at grade. Landscaping options will be limited to plants with shallow roots in areas where tiebacks are required for the trench retaining walls.	Railroad tracks will be approximately 15 feet above grade. Landscaping with trees will be incorporated for screening where feasible.	Railroad tracks will be approximately 20 feet above grade. Landscaping with trees will be incorporated for screening where feasible.	Railroad tracks will be below grade with high fencing at grade in the trench section. Landscaping options will be limited to plants with shallow roots in areas where ground anchors are required for the trench section.	Passenger tracks will be below grade and freight tracks will be at-grade with high fencing. Landscaping options will be limited to plants with shallow roots in areas where ground anchors are required for the trench section.	Railroad tracks will remain at-grade. On Charleston Rd, removal of the planting strip on both sides of the road will be required along with the planting strip on the east side of Alma St between Charleston Rd and Ely Pl.
J	Minimize disruption and duration of construction	Extended road closures at Meadow Dr and Charleston Rd are required. Construction would last for approximately 6 years.	Extended lane reductions at Alma St, Meadow Dr, and Charleston Rd will be required. Construction would last for approximately 4 years.	The viaduct will have minimal road closures (nights/weekends only). Construction would last for approximately 2 years.	Extended lane reductions on Alma St are required. Construction would last for approximately 6 years.	Extended Lane reductions on Alma St are required. Construction would last for approximately 6 years.	Lane reductions and temporary closures (nights/weekends only) on Alma St, a closure of Meadow Dr between Emerson St and Park Blvd, and a closure of Charleston Rd between Alma St and Park Blvd will be required for the majority of construction. The total duration of construction will be approximately 3.5 to 4 years; however the durations are subject to change depending on the construction methodologies used.
Order of Magnitude Cost		\$800M to 950M*	\$200M to \$250M*	\$400M to 500M*	\$1,218M to \$1,827M*	\$1,173M to \$1,759M*	\$350M to \$450M*

* Total Preliminary Construction Cost for infrastructure of both railroad crossings in 2018 dollars with escalation to 2025 (Subject to Change).



Summary of Engineering Challenges

Meadow / Charleston

Engineering Challenges		Trench	Hybrid	Viaduct	South Palo Alto Tunnel Passenger and Freight	South Palo Alto Tunnel with At-Grade Freight	Underpass
L	Creek/Drainage Impacts	<ul style="list-style-type: none"> Requires diversion of Adobe and Barron creeks resulting in the need for pump stations. Numerous regulatory agency approvals required for creek diversion. Pump stations also required to dewater the trench. Increased risk of flooding due to pump stations. 	<ul style="list-style-type: none"> Pump stations required for lowered roadways. Increased risk of flooding due to pump stations. 	<ul style="list-style-type: none"> No significant creek or drainage impacts. 	<ul style="list-style-type: none"> Requires diversion of Adobe and Matadero creeks resulting in the need for pump stations. Numerous regulatory agency approvals required for creek diversion. Pump stations also required to dewater the trench and tunnel. Increased risk of flooding due to pump stations. 	<ul style="list-style-type: none"> Requires diversion of Adobe and Matadero creeks resulting in the need for pump stations. Numerous regulatory agency approvals required for creek diversion. Pump stations also required to dewater the trench and tunnel. Increased risk of flooding due to pump stations. 	<ul style="list-style-type: none"> Pump station required for lowered roadways. Increased risk of flooding due to pump station.
M	Long-Term Maintenance	<p>Increased maintenance costs due to:</p> <ul style="list-style-type: none"> Pump stations for creek diversions. Pump stations for trench dewatering. Below ground railroad alignment. 	<p>Increased maintenance costs due to:</p> <ul style="list-style-type: none"> Pump stations for trench dewatering. Above ground railroad alignment with embankments and undercrossing structures. 	<p>Increased maintenance costs due to:</p> <ul style="list-style-type: none"> Above ground railroad alignment with embankments and viaduct structures. 	<p>Increased maintenance costs due to:</p> <ul style="list-style-type: none"> Pump stations for creek diversions. Pump stations for trench dewatering. Below ground railroad alignment. 	<p>Increased maintenance costs due to:</p> <ul style="list-style-type: none"> Pump stations for creek diversions. Pump stations for trench dewatering. Below ground railroad alignment as well as at-grade railroad alignment. 	<p>Increased maintenance cost due to:</p> <ul style="list-style-type: none"> Pump stations for underpass dewatering. Above ground structures for both road and rail.
N	Utility Relocations	<ul style="list-style-type: none"> Major utility relocations for lowered railroad. 	<ul style="list-style-type: none"> Major utility relocations for lowered roadways. 	<ul style="list-style-type: none"> No major utility relocations. 	<ul style="list-style-type: none"> Major utility relocations for lowered railroad. 	<ul style="list-style-type: none"> Major utility relocations for lowered railroad. 	<ul style="list-style-type: none"> Major utility relocations for lowered roadways.
O	Railroad Operations Impacts during Construction	<ul style="list-style-type: none"> Temporary track (i.e., shoofly) is required. 	<ul style="list-style-type: none"> Temporary track (i.e., shoofly) is required, but a bit shorter than the trench shoofly. 	<ul style="list-style-type: none"> No temporary track (i.e., shoofly) required. 	<ul style="list-style-type: none"> Temporary track (shoofly) is required. 	<ul style="list-style-type: none"> Temporary track (shoofly) is required. 	<ul style="list-style-type: none"> Temporary track (i.e., shoofly) likely required unless an alternate construction methodology and sequencing is acceptable to Caltrain.
P	Local Street Circulation Impacts during Construction	<ul style="list-style-type: none"> Removal of right turn lanes on Alma St at Meadow Dr and Charleston Rd; however, traffic will still be able to flow as needed despite lane reduction. Closes Meadow Dr while Charleston Rd roadway bridges are constructed and visa versa. 	<ul style="list-style-type: none"> Removal of right turn lanes on Alma St at Meadow Dr and Charleston Rd; however, traffic will still be able to flow as needed despite lane reduction. Alma St, Charleston Rd, and Meadow Dr reduced to 2 lanes. 	<ul style="list-style-type: none"> Reduced lane widths on Alma St, north of Meadow Dr and south of Charleston Rd. Possible night time closures of Meadow Dr and Charleston Rd. 	<ul style="list-style-type: none"> Alma St will be reduced to one lane in each direction from south of Oregon Expressway to Ventura Ave. From Charleston Rd to Ferne Ave, there will be only one southbound lane on Alma St. 	<ul style="list-style-type: none"> Alma St will be reduced to one lane in each direction from south of Oregon Expressway to Ventura Ave. 	<ul style="list-style-type: none"> Lane reduction on Alma St during construction of the shoofly and bridge. Closure of Meadow Dr and Charleston Rd throughout excavation and construction of the undercrossing and related features.
Q	Caltrain Design Exceptions Needed	2% grade on track required. Maximum grade allowed by Caltrain is 1%.	Temporary vertical clearance of 12 feet at undercrossing structures during construction. Minimum vertical clearance allowed by Caltrain is 15.5 feet.	1.4% grade on track required. Maximum grade allowed by Caltrain is 1%.	2% grade on track required. Maximum grade allowed by Caltrain is 1%.	2% grade on track required. Maximum grade allowed by Caltrain is 1%.	No Caltrain design exceptions required.

Improvement Impact

Summary of Evaluation with City Council-Adopted Criteria

Churchill

Evaluation Criteria		Closure	Viaduct	Partial Underpass
A	Facilitate movement across the corridor for all modes of transportation	Churchill Ave will be closed to vehicles at the railroad tracks.	Churchill Ave will be grade separated from the railroad for all modes and will remain open. Viaduct provides opportunities for additional crossings for all modes.	Churchill Ave will be grade separated from the railroad for all modes and will remain open. Through traffic on Churchill Ave is no longer possible, and some traffic will have to take alternate routes. Pedestrian/ bike (only) traffic will be grade separated from the railroad and vehicle traffic on Alma St via an undercrossing at Kellogg Ave.
B	Reduce delay and congestion for vehicular traffic at rail crossings	With closure of Churchill Ave, the traffic at nearby intersections will be impacted; however, this can be mitigated.	With construction of the grade separation, the railroad crossing gates and warning lights at Churchill Ave will be removed. Thus, the traffic will not be interrupted by railroad crossing gates.	With construction of the grade separation, the railroad crossing gates and warning lights at Churchill Ave will be removed. Thus, the traffic will not be interrupted by gates coming down. Pedestrian undercrossing at Kellogg Ave will also help reduce intersection congestion.
C	Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles	Pedestrians/cyclists will be separated from train traffic and vehicles.	Pedestrians/cyclists will be separated from train traffic.	Pedestrians and cyclists will be completely separated from train and vehicular traffic. Full Pedestrian and cyclist movement is maintained with the crossing relocated to Kellogg Ave.
D	Support continued rail operations and Caltrain service improvements	A temporary railroad track will not be required.	A temporary railroad track will be required. Stanford game day station will be eliminated due to grade issues.	A temporary railroad track is likely to be required unless an alternate construction methodology and sequencing is acceptable to Caltrain.
E	Finance with feasible funding sources	The closure would require the lowest levels of local funding, with a substantial portion of capital costs covered by Regional, State and Federal sources.	The viaduct would require substantial local funding resources significantly above the closure alternative.	The underpasses would require lower levels of local funding, substantial portion of the capital costs would be covered by regional, state and federal sources.
F	Minimize right-of-way acquisition	No acquisition of private properties is required; however, there will be impacts to Palo Alto High School property and potentially Caltrain. There also may be some parking loss on the east side of Churchill Ave for the pedestrian/bike undercrossing (Option 2 only).	No acquisition of private properties will be required.	Driveway modifications are likely to be required due to the removal of planter strips along Alma St. Some (sliver) acquisition of the high school and/or residential property fronting Churchill Ave on the west side of the tracks will be required. Some of the proposed improvements require encroachment inside Caltrain's right-of-way, especially during construction.
G	Reduce rail noise and vibration	Train horn noise and warning bells will be eliminated with the removal of the at-grade crossings with roadway closure. Utilizing electric engines instead of diesel engines will also reduce noise.	Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing electric engines instead of diesel engines will also reduce noise. With the elevated track, train wheel noise could radiate out, which can be mitigated.	Train horn noise and warning bells will be eliminated by the replacement of the at-grade crossings with grade separations. The use of electric motors rather than diesel engines will also reduce noise and some road noise would be reduced. Train wheel noise at the bridge location can be mitigated.
H	Maintain access to neighborhoods, parks, and schools along the corridor, while reducing regional traffic on neighborhood streets	Diversion of regional traffic with Churchill Ave closure will be mitigated.	No diversion of regional traffic with construction of a grade separations.	Regional traffic will be diverted due to the restricted turning movements. Pedestrian and cyclist access will significantly improve due to mode separation.
I	Minimize visual changes along the corridor	Railroad tracks remain at existing grade. Residual roadway areas from closure provide opportunities for landscaping.	Railroad tracks will be approximately 20 feet above grade. Landscaping with trees will be incorporated for screening where feasible.	The railroad tracks and the northbound lanes of Alma St will remain at-grade, and the east side of Churchill Ave will remain unchanged. Mature trees and overhead power poles within the Alma St planting strip, from just north of Kellogg Ave to just south of Coleridge Ave, will be removed.
J	Minimize disruption and duration of construction	The closure will have minimal road closures (nights/weekends only). Construction would last for approximately 2 years.	Extended lane reductions at Alma St (one lane in each direction) will be required. Construction would last for approximately 2 years.	Lane reductions on Alma St and closure of Churchill Ave between Alma St and Mariposa Ave will be required for the majority of construction. Total duration of construction will be approximately 2.5 to 3 years; however the durations are subject to change depending on the construction methodologies used.
Order of Magnitude Cost		\$50M to \$65M*	\$300M to \$400M*	\$160M to \$200M*

* Total Preliminary Construction Costs in 2018 dollars with escalation to 2025 (Subject to Change).

Improvement Impact

Summary of Engineering Challenges

Churchill

Engineering Challenges		 Closure	 Viaduct	 Partial Underpass
L	Creek/Drainage Impacts	<ul style="list-style-type: none"> Pump station required for lowered pedestrian/bike way. Increased risk of flooding with pump stations. Relocation of the pump house at Embarcadero Rd required to accommodate widening of Alma St. 	<ul style="list-style-type: none"> No significant creek or drainage impacts. 	<ul style="list-style-type: none"> Pump station required for lowered roadways. Increased risk of flooding due to pump station.
M	Long-Term Maintenance	Increased maintenance costs due to: <ul style="list-style-type: none"> Pump stations for undercrossing dewatering. 	Increased maintenance costs due to: <ul style="list-style-type: none"> Above ground railroad alignment with embankments and viaduct structures. 	Increased maintenance cost due to: <ul style="list-style-type: none"> Pump stations for underpass dewatering. Above ground structures for both road and rail.
N	Utility Relocations	<ul style="list-style-type: none"> Potential utility relocations in Alma St and Churchill Ave for pedestrian/bike undercrossing. Minor utility relocations for Embarcadero Rd/Alma St improvements. 	<ul style="list-style-type: none"> Minimal impacts to utilities. 	<ul style="list-style-type: none"> Major utility relocations for lowered roadways.
O	Railroad Operations Impacts during Construction	<ul style="list-style-type: none"> No temporary track (i.e., shoofly) required, only single tracking during nights and weekends. 	<ul style="list-style-type: none"> Temporary track (i.e., shoofly) is required. 	<ul style="list-style-type: none"> Temporary track (i.e., shoofly) likely required unless alternate construction methodology and sequencing is acceptable to Caltrain.
P	Local Street Circulation Impacts during Construction	<ul style="list-style-type: none"> Path along Palo Alto High School will temporarily be impacted during construction. Temporary night and weekend closures of lanes on Churchill Ave, Alma St and Embarcadero Rd. 	<ul style="list-style-type: none"> Alma St, reduced to two lanes. Removal of right turn lanes on Alma St at Churchill Ave; however, traffic will still be able to flow as needed despite lane reduction. Temporary night and weekend closures of lanes on Alma St and Churchill Ave. 	<ul style="list-style-type: none"> Lane reduction on Alma St during construction of the shoofly and bridge. Likely closure of Churchill Ave throughout the excavation and construction of the undercrossing and related features. Likely closure of Kellogg Ave for the duration of the pedestrian underpass construction; driveway access from one direction only.
Q	Caltrain Design Exceptions Needed	None required.	1.6% grade on track required. Maximum grade allowed by Caltrain is 1%.	No Caltrain design exceptions needed.

Improvement Impact